THE DETERMINATION OF THE COMPRESSIBILITIES OF RUBBER-LIKE POLYMERS

BY

PETER B. HILL

B.S., University of Delaware, 1948
M.S., University of Delaware, 1949

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AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN CHEMISTRY
IN THE GRADUATE COLLEGE OF THE
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Introduction

In order to characterize completely the thermodynamic state of elastomers, it can be shown that only a relatively small number of parameters need to be determined experimentally. One such parameter is the bulk compressibility. Unfortunately, due to the experimental difficulties encountered in high pressure work, studies of the compressibilities of elastomers have largely been neglected, except for occasional work done by specialists in high pressure techniques.

Experimental

An apparatus with which the compressibilities of rubber samples could be measured was designed and built. It consisted of a pressure gauge, an oil injector, a high pressure bomb, and a volume - measuring instrument. No difficulty was encountered in securing the first three components, but it was necessary to try several types of volume - measuring devices before a suitable one was found. The various models tried were adaptations of designs used by Richards[1], Drake[2], and Carnazzi[3]. It was found that Carnazzi's design enabled one to obtain far more reproducible data than either of the other models.

Results

Duplicate runs were made on several types of synthetic and natural rubbers, each of which was subdivided into three or four cure - time groups. The rubbers tested were natural gum and tread stocks, GR-S, GR-A, and butyl rubbers. In every case the relation of volume change to pressure was linear, and with one exception the compressibility was constant over the range of 1000 kg./sq. cm. The exception was the 30 minute cure natural gum stock, in which a second order

transition was found.

It was found that the compressibilities of the natural gum and GR-A rubbers decreased as the cure time increased. No such clear-cut trend for the behavior of the natural tread stock, GR-S, or the butyl rubber was found.

A comparison of these results with the findings of Adams and Gibson[4], Scott[5], and Bridgman[6,7,8] was made. These writers found that the pressure-volume change relationship was not constant, in contrast to the results reported here. However, the deviations from constancy were small, and were found for measurements made over a very much larger pressure range. Over the pressure range in which the present work was done, the compressibility data obtained are in substantial agreement with the literature values.

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VITA

The author was born on May 5, 1926 in Brooklyn, New York. He attended public schools in that city, in Cranford, New Jersey, and in Wilmington, Delaware. Following his graduation from P.S. duPont High School in 1943 he entered the University of Delaware. In 1944 he was inducted into the Air Force and served at various posts in the United States for two years. After completing this service he returned to the University of Delaware and was awarded the degrees of Bachelor of Science with Distinction in Chemistry in 1948, and Master of Science in 1949.

Following his marriage to Miss Helen Notarys of Wilmington, Delaware, the author entered the Graduate College of the University of Illinois in September, 1949. He held a teaching assistantship from September 1949 until June 1950, and a research assistantship from June 1950 until October 1952.